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Technology Transfer Technical Note No. 2

Tropical Crops & Forages Nutrient Uptake

Purpose

The purpose of this technical note is to provide guidance in nutrient uptake values by tropical crops in order to make fertilization recommendations and nutrient management.

Discussion

Most growing plants absorb nutrients from the soil. Nutrients are eventually distributed through the plant tissues. Nutrients extracted by plants refer to the total amount of a specific nutrient uptake and is the total amount of a particular nutrient needed by a crop to complete its life cycle. It is important to clarify that the nutrient extraction value may include the amount exported out of the field in commercial products such as; fruits, leaves or tubers or any other part of the plant. Nutrient extraction varies with the growth stage, and nutrient concentration potential may vary within the plant parts at different stages. It has been shown that the chemical composition of crops, and within individual components, changes with the nutrient supplies, thus, in a nutrient deficient soil, nutrient concentration in the plant can vary, creating a deficiency or luxury consumption as is the case of Potassium.

The nutrient uptake data gathered in this note is a result of an exhaustive literature review, and is intended to inform the user as to what has been documented. It describes nutrient uptake from major crops grown in the Caribbean Area, Hawaii and the Pacific Basin. Because nutrient uptake is crop, cultivar, site and nutrient content specific, unique values cannot be arbitrarily selected for specific crops. This database serves as a reference to guide the decision in preparing on-farm comprehensive nutrient management plans and as fertilizer guidance.

Use example: If land resources are limited and the objective is to land apply as much Nitrogen and Phosphorus as possible, then the nutrient management plan must use crops that can remove large amounts of nutrients. The user should select as a reference point the example that best exemplifies what is being performed on-farm under the present environmental conditions and technical availability.

The database:

Each of the data resource gathered was ranked in terms of confidence associated with the data. The classification given was highly valid (1), valid (2), or poorly valid (3). This data may help the user is selecting which study is more appropriate for its intended use. Crop nutrient uptake values are in Table 1.

Table 1. Crop/Forage nutrient uptake values by some tropical crops.

Crop	Scientific name	Variety	Yield (Kg/ha/yr)	Nutrient extraction (kg/ha/yr)					Comment	Reference	Confidence [1]
				N	P	K	Ca	Mg			
Grass											
Napier grass (Elefante)	*Pennisetum purpureun* Schum.		28200	338	72	564	108	71	Experiment performed in Puerto Rico in limed soil to pH 6.0, with six nutrient applications per year of 450, 73 and 450 kg/ha of N, P and K, respectively. The grass was cut every 60 days.	(25)	1
Napier grass (Elefante)	*Pennisetum purpureun* Schum.		37278	323	67	747	102	67	Experiment performed in Puerto Rico in Catalina clay soil, with N aplication rate of 896 kg/ha. The grass was cut every 60 days.	(20)	1
Guinea grass	*Urochloa maxima* (Jacq.) R. Web.		25800	323	49	407	167	111	Experiment performed in Puerto Rico in limed soil to pH 6.0, with six nutrient applications per year of 450, 73 and 450 kg/ha of N, P and K, respectively. The grass was cut every 60 days.	(25)	1
Guinea grass	*Urochloa maxima* (Jacq.) R. Web.		31561	336	51	634	175	116	Experiment performed in Puerto Rico in Catalina clay soil, with N aplication rate of 896 kg/ha. The grass was cut every 60 days.	(20)	1
Pangola grass	*Digitaria eriantha* Steud		26500	335	53	400	122	75	Experiment performed in Puerto Rico in limed soil to pH 6.0, with six nutrient applications per year of 450, 73 and 450 kg/ha of N, P and K, respectively. The grass was cut every 60 days.	(25)	1
Pangola grass	*Digitaria eriantha* Steud		29888	339	54	624	124	75	Experiment performed in Puerto Rico in Catalina clay soil, with N aplication rate of 896 kg/ha. The grass was cut every 60 days.	(20)	1

Malojillo (Pará grass)	*Urochloa mutica* (Forssk) T. Q. Nguyen		26900	344	48	429	129	88	Experiment performed in Puerto Rico in limed soil to pH 6.0, with six nutrient applications per year of 450, 73 and 450 kg/ha of N, P and K, respectively. The grass was cut every 60 days.	(25)	1
Malojillo (Pará grass)	*Urochloa mutica* (Forssk) T. Q. Nguyen		29180	344	48	591	129	89	Experiment performed in Puerto Rico in Catalina clay soil, with N aplication rate of 896 kg/ha. The grass was cut every 60 days.	(20)	1
Congo grass	*Urochloa ruziziensis* (R. Germ. & Evrard) Crins		33500	342	55	450	153	78	Experiment performed in Puerto Rico in limed soil to pH 6.0, with six nutrient applications per year of 450, 73 and 450 kg/ha of N, P and K, respectively. The grass was cut every 60 days.	(25)	1
Star grass	*Cynodon nlemfuensis* var. *nlemfuensis*		28300	388	65	469	151	54	Experiment performed in Puerto Rico in limed soil to pH 6.0, with six nutrient applications per year of 450, 73 and 450 kg/ha of N, P and K, respectively. The grass was cut every 60 days.	(25)	1
Star grass	*Cynodon nlemfuensis* var. *nlemfuensis*		26917	554	57	513	164	73	Experiment performed in Puerto Rico in Humatas clay soil, with N aplications rate of 896 kg/ha. The grass was cut every 60 days.	(21)	1
Molasses grass (Melao)	*Melinis minutiflora* Beauv.		13369	422	65	602	116	89	Experiment performed in Puerto Rico in Catalina clay soil, with N aplication rate of 896 kg/ha. The grass was cut every 60 days.	(20)	1
Molasses grass (Melao)	*Melinis minutiflora* Beauv.		14800	232	36	233	63	49	Experiment performed in Puerto Rico in limed soil to pH 6.0, with six nutrient applications per year of 450, 73 and 450 kg/ha of N, P and K, respectively. The grass was cut every 60 days.	(25)	1
Farinaceous											

Cassava (Tapioca)	*Manihot esculenta* Crantz	cv. Llanera	23000	137					Experiment performed in Puerto Rico in Humatas soil. Values include leafs, stems, and tubers and is the mean of the highest three yielding N treatments. It is estimated that 27% of the total is exported in the tuber.	(38)	1
			32300	159					Experiment performed in Puerto Rico in Torres clay soil. Values includes leafs, stems, and tubers and is the mean of the highest three yielding N treatments. It is estimated that 39% of the total is exported in the tuber.		
Cassava (Tapioca)	*Manihot esculenta* Crantz	var. M Col 22	8413	164	15	76	58	22	Experiment performed in Colombia in Typic Dystropept with density of 15625 plants/ha.Values include leaves, petiole and stem a dry matter basis.	(46)	1
			21672	152	22	163	20	11	Experiment performed in Colombia in Typic Dystropept with density of 15625 plants/ha.Values include roots on a dry matter basis.		
			30084	316	37	238	77	32	Experiment performed in Colombia in Typic Dystropept with density of 15625 plants/ha. Values include whole plant a dry matter basis.		
Cassava (Tapioca)	*Manihot esculenta* Crantz	cv. Llanera	37500	204	12	222	86	33	Experiment performed in Puerto Rico in Corozal clay soil. The nutrient extraction values includes leafs, stems, and tubers; 25% of total N, 42% of total P, 50% total K is exported in tuber a dry matter basis. Yield is expresed as marketable tubers.	(53)	1
Cassava (Tapioca)	*Manihot esculenta* Crantz	var. M Ven 77	37500	67	17	102			Experiment performed in Colombia. Values included tubers only.	(45)	2
Cassava (Tapioca)	*Manihot esculenta* Crantz	Not reported	30000	164	31	200	80	31	Experiment performed in Colombia. Values included tubers only.	(6)	2
Tanier (Taro)	*Xanthosoma* spp.	var. Blanca del pais	23401	307	83	417	112	68	Experiment performed in Puerto Rico in Oxisol soil, with drip irrigation. Yield is	(40)	1

Tanier (Taro)	*Xanthosoma atrovirens* C. Koch & Bouché	var. Morada	34068	272	73	454	98	53	expressed as marketable tubers. The nutrient extraction values includes the whole plant.		
Tanier (Taro) (Kelly)	*Xanthosoma atrovirens* C. Koch & Bouché	var. Amarilla	11316	145	40	220	63	33			
Tanier (Taro)	*Xanthosoma* spp.	var. Blanca del pais	19479	165	76	582	114	44	Experiment performed in Puerto Rico in Mollisol soil; whit drip irrigation. Maximum yields were obtained at 12 months after planting. Throughout the experimental period, fertigation was provided monthly at the rate of 3.7 and 8.0 kg/ha of N and K, respectively and each plant received 3.5 gr of granular P.	(39)	1
Tanier (Taro) (Morada)	*Xanthosoma atrovirens* C. Koch & Bouché	var. Morada	11450	125	15	156	25	48	Experiment performed in Puerto Rico in Mabi clay soil. Yield corresponds to tuber harvested twelve months after planting and nutrient extraction values corresponded to whole plant.	(26)	1
Water yam	*Dioscorea alata* L.	Ñame de agua	31749	118	19	160				(12)	2
Water yam	*Dioscorea alata* L.	cv. Gunung	58764	214	19	223	95	9	Experiment performed in Puerto Rico in Ultisol soil, 77% of total N, 74% of total P, 75% total K is exported in tuber.	(55)	1
Guinea yam	*Dioscorea rotundata* Poir in Lam	cv. Habanero	51600	190	25	215	90	35	Experiment performed in Puerto Rico in Corozal clay soil (Ultisol), with rate fertilizer of 2244 kg/ha of 15-5-20-3 (N, P2O5, K2O and MgO). The tubers yields were harvest 8 months after planting; 71% of total N, 84% of total P, 74% total K is exported in tuber a dry matter basis.	(54)	1
Guinea yam	*Dioscorea rotundata* Poir in Lam	var. White yam	8960	123	9	78			Experiment performed in Nigeria. Yield and nutrient extraction values corresponded to tuber a dry matter basis.	(92)	2
Water yam	*Dioscorea alata* L.	Not reported	9030	129	17	162	3	8	Experiment performed in Nigeria on loam soil. The values corresponds to nutrient	(70)	1

Yellow guinea yam	*Dioscorea cayenensis*	Not reported	15260	139	19	182	4	13	removal by tubers only on a dry matter basis.		
Guinea yam	*Dioscorea rotundata*	cv. Efuru	12130	155	18	176	4	11			
	Dioscorea rotundata	cv. Aro	12200	140	18	155	3	11			
Guinea yam	*Dioscorea rotundata*	var. Diamantes 22 (6322)	23200	102	12	101	4	6	Experiment performed in Costa Rica. Yield corresponded to tubers on a fresh matter basis.	(82) as cited by (14)	2
Banana	*Musa acuminata* Colla	var. Grand Nain	27477	276	23	711	152	54	Experiment performed in Puerto Rico in Ultisol soil, with aplication of three fertilizer treatments of 0, 1340 and 2680 kg/ha/crop of a 10-5-30-3 of N, P2O5, K2O, MgO, respectively and supplemented with 23 kg/t of minor elements.	(56)	1
Banana	*Musa acuminata* Colla	Banano organico var. Gross Michel	8100	30	4	232	29	5	Yield expressed in kg nutrient per kg of fresh fruit. The nutrient extraction values corresponds to the whole plant.	(100) as cited by (14)	2
		Banano organico var. Congo	8100	45	7	203	41	15	Yield expressed in kg nutrient per kg of fresh fruit. The nutrient extraction values corresponds to the whole plant.		
Banana	*Musa acuminata Colla*	Not reported	70000	126	15	399			The extraction and yield values are expresed for one harvest.	(61)	2
Plantain	*Musa paradisiaca*	Not reported	26000	223	18	601	158	156	Experiment performed in Puerto Rico in Mabi clay soil, fertilized with a 10-5-15-12 fertilizer (N, P2O5, K2O and MgO) applied in rates of 0, 1350 and 2700 kg/ha, divided in four equal applications. Yield correspond to fruit only. Nutrient extraction values corresponded to whole plant on a dry matter basis. The higher Mg levels were explained previously as "luxury" uptake beyond the plants needs, resulting from high Mg levels in the soil.	(57)	1

			33000	275	24	569	136	48	Experiment performed in Puerto Rico in Corozal clay soil, fertilized with a 10-5-20-4 fertilizer (N, P2O5, K2O and MgO) applied in rates of 0, 2000 and 4000 kg/ha, divided in four equal applications. Yield correspond to fruit only. Nutrient extraction values corresponded to whole plant a dry matter basis.		
Plantain	*Musa paradisiaca*	Not reported	29022	131	6	294	81	14	Experiment performed in Puerto Rico in Humatas clay, fertilizer with 10-5-20 (N, P2O5, K2O) applied a the rate of 678.3 kg/ha in three aplications at a density of 2,988 plants/ha. The values of nutrient exported was evaluated in the leaves a dry matter basis.	(88)	1
				131	7	1177	127	31	Experiment performed in Puerto Rico in Humatas clay, fertilizer with 10-5-20 (N, P2O5, K2O) applied a the rate of 678.3 kg/ha in three aplications at a density of 2,988 plants/ha. The values of nutrient exported was evaluated in the pseudostem a dry matter basis.		
				70	9	242	2	11	Experiment performed in Puerto Rico in Humatas clay, fertilizer with 10-5-20 (N, P2O5, K2O) applied a the rate of 678.3 kg/ha in three aplications at a density of 2,988 plants/ha. The values of nutrient exported was evaluated in the fruit a dry matter basis.		
				332	22	1713	210	56	Experiment performed in Puerto Rico in Humatas clay, fertilizer with 10-5-20 (N, P2O5, K2O) applied a the rate of 678.3 kg/ha in three aplications at a density of 2,988 plants/ha. The values of nutrient exported was evaluated in whole plant a dry matter basis.		
Horticultural											
Kidney bean	*Phaseolus vulgaris* L.	Not reported	1000	102	9	93	54	18	Nutrient extraction in whole plant and bean.	(89)	1
			1000	84	7	68	34	11	Nutrient extraction in whole plant and bean.		
			1000	81	7	62	57	10	Nutrient extraction in whole plant and bean.		

			1000	101	18	201	116	36	Nutrient extraction in whole plant and bean.		
			1000	34	3	20	4	4	Nutrient extraction in bean only.		
			1000	37	4	22	4	4	Nutrient extraction in bean only.		
			1000	22	4	13	3	2	Nutrient extraction in bean only.		
				35	4	19	1	2	Nutrient extraction in bean only.		
Kidney bean	*Phaseolus vulgaris* L.	var. Bribri	3500	156	23	222	117	26	The experiment was performed in Costa Rica. Plant density was 156,000 plants/ha.	(15)	1
		var. Sacapobres	2500	191	25	189	143	33	The experiment was performed in Costa Rica. Plant density was 178,500 plants/ha.		
Kidney bean	*Phaseolus vulgaris* L.	Not reported	1000	36	4	15	3	3	Yield and nutrient extraction values expressed in kg grain/ha.	(84)	3
Kidney bean	*Phaseolus vulgaris* L.	Not reported	1000	32	3	20	4	3	Experiment performed in Colombia. Yield and nutrient extraction values expressed in kilograms of grain.	(47)	1
				102	9	93	54	18	Experiment performed in Colombia. Nutrient extraction values expressed in whole plant a dry matter basis.		
Kidney bean	*Phaseolus vulgaris* L.	cv. Kaboon cv. Manteigao cv. Carioca	2970	60	5	48			Experiment performed in Brasil in Argissolo soil. Yield and extraction values correnponded to average of three cultivars (Kaboon, Manteigao and Carioca) analized 70 days after planting. The parts analized were leaf, stem and root on a dry matter basis.	(73)	1
			2884	45	4	29			Experiment performed in Brasil on Argissolo soil. Yield and extraction values correnpondede to average of three cultivars (Kaboon, Manteigao and Carioca) analized 70 days after planting. The parts analized were the string bean.		
Garden cucumber	*Cucumis sativus* L.	Not reported	30000	50	40	80				(59)	2
Garden cucumber	*Cucumis sativus* L.	Not reported	10000	101	13	162			Experiment performed in Duplin fine sandy loam with density of 21,511 plants/ha. The yield is expresed on fresh weight basis.	(65)	2
Garden lettuce	*Lactuca sativa* L.	Not reported	29689		10	146			Experiment performed in Indian River county on a Terra Ceia muck soil. The nutrient extraction at harvest was calculated from wrapper leaves and head analyses	(34)	1

									during winter season.		
Garden lettuce	*Lactuca sativa* L.	Not reported		107	14	191			Numbers are total values removed by crop	(62)	2
Garden lettuce	*Lactuca sativa* L.	cv. South bay	20450		24				Experiment performed in Florida in Histosol with density of 60,000 plants/ha, during winter season.	(69)	1
		cv. Raleigh	16700		22						
		cv. Salinas	19500		22						
		cv. Ithaca	11500		19						
		cv. Florical 50011	29100		25						
		cv. Florical 48060	16400		21						
Garden lettuce	*Lactuca sativa* L.	Not reported	18000	45	11	54	9	5		(102) as cited by (14)	2
Garden lettuce	*Lactuca sativa* L.	Not reported	30000	75	24	120	36	9		(37) as cited by (14)	2
Garden onion	*Allium cepa* L.	var. Ringer Grano	28482	50	12	34	16	4	Experiment performed in Puerto Rico in San Anton soil with aplication of N, K2O and P2O5, at a rate of 75, 155 and 25 kg/ha, respectively and sprinkle irrigation. Nutrient extraction was evaluated in the bulb; 131 days after planting.	(30)	1
				14	2	17	22	6	Experiment performed in Puerto Rico in San Anton soil with aplication of N, K2O and P2O5, at a rate of 75, 155 and 25 kg/ha, respectively and sprinkle irrigation. Nutrient extraction was evaluated in the foliage 131 days after planting.		

Garden onion	*Allium cepa* L.	Not reported	640 crates/acre or 96 bunches/crate	74	11	88	31	7	Experiment performed in Salinas Valley in Puerto Rico. Values corresponded to average of three trials development in soils: Salinas clay, Salinas fine sandy loam and Salinas silty clay loam, at density of 1,290,617 plants/ha.	(107)	1
Garden onion	*Allium cepa* L.	Not reported		163	28	174			Numbers are total values removed by crop	(62)	2
Garden onion	*Allium cepa* L.	var. Gladalan brown	30800	59	4	46	9	4	Nutrient extraction was evaluated in the bulb 149 days after to planted.	(77) as cited by (14)	2
				44	1	27	11	4			
		var. Granex 33	27000	48	3	42	8	5			
				35	2	33	15	5			
		var. Regia	28700	50	7	64	14	6			
				38	2	42	20	6			
		var. Sonic	24500	58	8	61	17	7			
				58	3	50	15	7			
Garden onion	*Allium cepa* L.	Not reported	24600	38	8	66	7	3	Nutrient extraction was evaluated in the bulb only.	(78) as cited by (14)	1
Cayenne pepper	*Capsicum annuum* L.	Not reported		157	14	157			Numbers are total values removed by crop	(62)	2
Cayenne pepper	*Capsicum annuum* L.	cv. Cubanelle	51251	171	21	218			Study conducted in a San Anton (Mollisol) soil with N aplications via drip irrigation and plastic mulch. The extraction values was quantified with a density of 43,200 plants/ha.	(32)	1

			31042	101	11	127			Study was conducted in a San Anton (Mollisol) soil with N aplication in plastic mulch. The extraction values were quantified with a density of 43,200 plants/ha. Extraction values correspond to fruit and vegetative plants partion.		
Cayenne pepper	*Capsicum annuum* L.	var. Key largo	10898	125					Experiment performed in Puerto Rico in Fraternidad clay soil. 82% of the uptake the plant (stem, root and leaf) and 18% in the fruit.	(17)	1
Cayenne pepper	*Capsicum annuum* L.	Not reported	11830	98					Nutrient extraction was evaluated in the root, leaf, stems and fruits 77 days after to planted.	(75)	
Irish potato	*Solanum tuberosum* L.	Not reported		236	34	309			Numbers are total values removed by crop	(62)	2
Irish potato	*Solanum tuberosum* L.	var. White rose	12000	178					Nutrient extraction was evaluated in the tuber, 125 days after planting.	(97)	1
Irish potato	*Solanum tuberosum* L.	Not reported	20804	55	9	75				(52)	3
Irish potato	*Solanum tuberosum* L.	Not reported	74000	199					Experiment performed in Paterson, Washington (USA) on a Quincy loamy sand, irrigated by sprinklers. Nutrient extraction was evaluated in the tuber.	(83)	1
				297					Experiment performed in Paterson, Washington (USA) on a Quincy loamy sand, irrigated by sprinklers. Nutrient extraction in whole plant.		
Irish potato	*Solanum tuberosum* L.	Not reported	57900	105	26	261	4	7		(4) as cited by (7)	3
Irish potato	*Solanum tuberosum* L.	cv. Atlantic	28900	75	13	110	1	5	Experiment performed in sandy Humaquept with high levels of accumulated Ca and P. Nutrient extraction values correspond to tubers only, based on the moisture contents of 810 g/kg.	(106)	1
			11400	23	2	54	28	26	Experiment performed in sandy Humaquept with high levels of accumulated Ca and P. Nutrient extraction values correspond to the		

									vegetative part.		
Irish potato	*Solanum tuberosum* L.	var. Atzimba	26200	124	11	117	3	7	Nutrient extraction in the tuber.	(93) as cited by (14)	2
				64	3	56	11	7	Nutrient extraction in the vegetative plant portion.		
		var. Floresta	39900	183	15	165	4	8	Nutrient extraction in the tuber.		
				194	8	148	34	27	Nutrient extraction in the vegetative plant portion.		
		var. Granola	37900	155	15	218	4	11	Nutrient extraction in the tuber.		
				70	3	63	20	11	Nutrient extraction in the vegetative plant portion.		
		var. Idiap	32700	152	15	146	13	7	Nutrient extraction in the tuber.		
				205	8	126	21	20	Nutrient extraction in the vegetative plant portion.		
		var. Rosita	31700	143	15	233	4	12	Nutrient extraction in the tuber.		
				121	6	177	26	14	Nutrient extraction in the vegetative plant portion.		
		var. Tollocan	47800	226	22	274	7	14	Nutrient extraction in the tuber.		
				150	7	243	30	22	Nutrient extraction in the vegetative plant portion.		
		var. Clon 21.15	36300	157	16	168	5	10	Nutrient extraction in the tuber.		
				85	4	101	10	10	Nutrient extraction in the vegetative plant portion.		
		var. Clon 46.47	23800	104	11	165	3	8	Nutrient extraction in the tuber.		
				26	1	45	6	4	Nutrient extraction in the vegetative plant portion.		
		var. Clon 83.80	22500	79	9	141	3	7	Nutrient extraction in the tuber.		
				58	3	79	12	6	Nutrient extraction in the vegetative plant portion.		
Corn	*Zea mays* L.	Not reported	10300	134	41	49	3	16	Experiment performed in five states (Delaware, Massachusetts, Maryland, New Jersey, and Pennsylvania) in Alfisol and Ultisol soil. Yield and nutrient extraction values correspond to the grain dry and is the	(42)	1

									average of ten hybrids .		
Corn	*Zea mays* L.	Not reported	9500	129	31	39	1	11	Yield and nutrient extraction values correspond to the grain only.	(13)	1
Corn	*Zea mays* L.	Not reported	150 bu/acre	134	28	34	1	9	Experiment performed in Wisconsin.	(18)	3
Corn	*Zea mays* L.	Not reported	11300	190	34	45		18	Yield and nutrient extraction values correspond to the grain only.	(50)	2
				78	15	179		38	Yield and nutrient extraction values correspond to the stem only.		
Corn	*Zea mays* L.	Not reported	6300	100	17	24	6	1		(2) as cited by (43)	3
Corn	*Zea mays* L.	Not reported	5075	74	15	20	1	5		(104)	2
Corn	*Zea mays* L.	Not reported	9000	131	27	36	2	8		(49)	2
Sweet corn	*Zea mays* L.	Not reported		174	22	118			Numbers are total values removed by crop	(62)	2
Sweet potato	*Ipomoea batatas* (L.) Lam	Not reported		157	22	224			Numbers are total values removed by crop	(62)	2
Sweet potato	*Ipomoea batatas* (L.) Lam	Not reported	14000	52	8	59	5	4	Nutrient extraction correspond to tubers and leaves.	(105) as cited by (1)	3
Garden tomato	*Solanum lycopersicum* var. *lycopersicum*	Not reported		202	24	314			Numbers are total values removed by crop	(62)	2
Garden tomato	*Solanum lycopersicum* var. *lycopersicum*	Not reported		78					Experiment performed in Georgia in Norfolk sandy loam soil. The nutrient extraction values is the average of two years in whole plant to dry matter basis.	(99)	2
Garden tomato	*Solanum lycopersicum* var. *lycopersicum*	Not reported		159					Experiment performed in North Florida on Orangeburg loamy fine sand soil. Maximum amount of N removed with highest N application rate.	(3)	1

Garden tomato	*Solanum lycopersicum* var. *lycopersicum*	var. Catalina	102100	259	59	410	192	101		(24) as cited by (14)	2
Garden tomato	*Solanum lycopersicum* var. *lycopersicum*	Not reported	90000	260	42		33	40		(76) as cited by (14)	2
Cabbage	*Brassica oleracea* L.	var. Bronco	70300	129	9	89	19	6	Yield expressed in fresh matter basis. Values of nutrient exported was evaluated 100 days after planting.	(94) as cited by (14)	2
		var. Ranchero	74900	123	11	177	27	8			
Cabbage	*Brassica oleracea* L.	var. Itzalco	45500	217	16	294	177	36	Yield expressed in fresh matter basis. Values of nutrient exported was evaluated 75 days after planting.	(68)	2
Cabbage	*Brassica oleracea* L.	Not reported	78400	302	31	232	39	40		(5) as cited by (14)	2
Cabbage	*Brassica oleracea* L.	Not reported	84000	280	31	249		36		(63) as cited by (14)	2
White pear (Chayote)	*Sechium edule* (Jacq.) Sw.	Tallón	27000	41	2	85	10	9	Experiment performed in Costa Rica. Nutrient extraction value included foliage (leaf, stem, petioles, zarcillos and flowers), analized 195 days after to planting.	(101)	1
				7	0.4	8	0.4	1	Experiment performed in Costa Rica. Nutrient extraction values correspond to the fruit analized 195 days after to planting. The fruit absorbed 15.2 % of the total plant N uptake 16.5% of the P, 8.2% of the K, 3.9% of the Ca, and 8.4% of the Mg.		
				48	2	93	10	9	Experiment performed in Costa Rica. Nutrient extraction values included whole plant. The yields are expressed in kg fresh matter basis.		
Okra	*Abelmoschus esculentus* (L.) Moench.	Guingombó	10000	21	4	52	33	2		(44) as cited by (14)	2

Fruits											
Cantaloupe	*Cucumis melo* L.	var. PMR450	1929	43	5	24	9	15	Experiment performed in California in Ramona sandy loam and Noncalcic Brown soils. Nutrient extraction corresponds to foliage analized 170 days from planting. The plant was fertilized with 134.4 and 58 kg/ha of N and P, respectively.	(98)	1
				51	8	64	6	8	Experiment performed in California in Ramona sandy loam and Noncalcic Brown soils. Nutrient extraction corresponds to fruits analized 170 days from planting. The plant was fertilized with 134.4 and 58 kg/ha of N and P, respectively.		
		var. Crenshaw	2302	49	7	49	11	23	Experiment performed in California in Ramona sandy loam and Noncalcic Brown soils. Nutrient extraction corresponds to foliage analized 170 days from planting. The plant was fertilized with 134.4 and 58 kg/ha of N and P, respectively.		
				32	7	48	7	6	Experiment performed in California in Ramona sandy loam and Noncalcic Brown soils. Nutrient extraction corresponds to fruits analized 170 days from planting. The plant was fertilized with 134.4 and 58 kg/ha of N and P, respectively.		
		var. Honey Dew	3024	63	8	38	14	30	Experiment performed in California in Ramona sandy loam and Noncalcic Brown soils. Nutrient extraction corresponds to foliage analized 170 days from planting. The plant was fertilized with 134.4 and 58 kg/ha of N and P, respectively.		
				42	8	58	12	7	Experiment performed in California in Ramona sandy loam and Noncalcic Brown soils. Nutrient extraction corresponds to fruits analized 170 days from planting. The plant was fertilized with 134.4 and 58 kg/ha of N and P, respectively.		

		var. Persian	3037	90	11	104	12	33	Experiment performed in California in Ramona sandy loam and Noncalcic Brown soils. Nutrient extraction corresponds to foliage analized 170 days from planting. The plant was fertilized with 134.4 and 58 kg/ha of N and P, respectively.		
				60	7	73	17	9	Experiment performed in California in Ramona sandy loam and Noncalcic Brown soils. Nutrient extraction corresponds to fruits analized 170 days from planting. The plant was fertilized with 134.4 and 58 kg/ha of N and P, respectively.		
Cantaloupe	*Cucumis melo* L.	var. Honey Dew	43500	24	4	23	70	14	Extraction values include foliage analized 60 days after planting.	(80) as cited by (14)	2
				25	7	69	9	6	Extraction values include fruits analized 60 days after planting, yield expresed on a fresh matter basis.		
Cantaloupe	*Cucumis melo* L.	var. Moonshine	44600	35	10	89	7	7	Extraction values include foliage analized 60 days after planting.	(81) as cited by (14)	2
				29	4	63	45	7	Extraction values include fruits analized 60 days after planting, yield expresed a fresh matter basis.		
Watermelon	*Citrullus lanatus* (Thunb.) Matsum. & Nakai	var. Crimson Jewel	44000	18	4	50	6	3	Yields are expresed on a fresh matter basis. Nutrient extraction correponds to fruits.	(80) as cited by (14)	2
Watermelon	*Citrullus lanatus* (Thunb.) Matsum. & Nakai	var. Mickeylee - convencional	51900	20	3	30	3	3	Yields are expresed on a fresh matter basis. Nutrient extraction correponds to fruits.	(103) as cited by (14)	2
		var. Mickeylee - fertirriego	39800	24	3	30	3	3			
Sweet orange	*Citrus sinensis* (L.) Osbeck	Not reported		38	4	53	14	6	Values are those removed in fruit. Assume in 300 oranges/tree, with 200 trees/acre, and 24,000 lbs oranges/acre.	(96)	1
Sweet orange	*Citrus sinensis* (L.) Osbeck	Not reported	40000	60	12	96	26	12		(66)	2

Sweet orange	*Citrus sinensis* (L.) Osbeck	var. Valencia	24000	44	4	43	19	4		(87) as cited by (14)	2
Mango	*Mangifera indica* L.	var. Glenn	11520	60	11	61	65	25	Experiment performed in Maracay in a Venezuela Mollisol soil, with a density of 72 trees/ha. Nutrient extraction values correspond to fruits.	(58)	1
Mango	*Mangifera indica* L.	var. Tommy atkins	12456	112	16	68	66	55			
Mango	*Mangifera indica* L.	var. Ford	11160	73	6	59	54	32			
Mango	*Mangifera indica* L.	var. Bocado	18576	98	6	102	98	45			
Mango	*Mangifera indica* L.	var. Springfels	20304	117	8	135	120	65			
Mango	*Mangifera indica* L.	var. Manga criolla	10944	80	8	96	55	44			
Mango	*Mangifera indica* L.	var. Zill	15912	46	14	95	75	45			
Mango	*Mangifera indica* L.	var. Irwin	101523	56	15	64	75	29			
Mango	*Mangifera indica* L.	var. Harri	7560	69	6	43	34	22			
Mango	*Mangifera indica* L.	var. Smith	21720	248	28	154	171	61			
Mango	*Mangifera indica* L.	var. Haden	30024	151	27	201	151	79			
Mango	*Mangifera indica* L.	var. Carrie	16128	116	13	97	100	42			
Mango	*Mangifera indica* L.	var. Edward	10048	86	5	93	86	67			
Mango	*Mangifera indica* L.	var. Kent	20034	143	9	117	85	56			
Mango	*Mangifera indica* L.	Not reported	15914	104	12	99	88	47	Experiment performed in Venezuela in Mollisol, with a density of 72 trees/ha. The values are the average of 14 varieties: Glenn, Tommy Atkins, Irwin, Harri, Smith, Haden, Zill, Carrie, Manga Criolla, Edward, Kent, Springfels, Ford and Bocado.		

Mango	*Mangifera indica* L.	var. Manila	10500	13	2	20	3	2	Experiment performed in Venezuela in Vertisol soil, with a density of 50 plants/ha. Nutrient extraction was evaluated in the fruits at physiological madurity.	(41)	1
Mango	*Mangifera indica* L.	cv. Kensington Pride	10000	11	2	15	2	2	Experiment performed in basalt and ferrosol soils. The values are the average of two study sities.	(48)	2
Papaya	*Carica papaya* L.	Not reported		1.8	0.3	2.7	0.7	0.3	Nutrient exported values expressed on a kg nutrient/1000 kg fresh fruit harvest basis.	(11) as cited by (14)	2
Papaya	*Carica papaya* L.	Not reported		1.8	0.3	2.3	0.5	0.3	Nutrient exported values expressed on a kg nutrient/1000 kg fresh fruit harvest basis.	(10) as cited by (14)	2
				1.7	0.3	1.2	0.2	0.2			
				1.8	0.2	2.1	0.4	0.2			
Avocado	*Persea americana* Mill	var. Pollock	25428	74	16	76	14	8	Yield expresed in fresh weight basis, with a density of 156 plants/ha. Extraction values correspond to fruit.	(8)	1
		var. Princesa	17472	48	13	58	11	6			
		var. Waldin	20904	63	17	73	14	6			
		var. Maria	26520	86	23	109	15	11			
Avocado	*Persea americana* Mill	cv. Hass	10000	41	8	61	7	8	Experiment performed on Krasnozem soil.	(48)	2
Avocado	*Persea americana* Mill	cv. Booth - 8	20000	37	5	45	2	5	Experiment performed in Tepic, Nayarit (Mexico) on soil texture sandy loam.	(85)	1
		cv. Choquette	20000	30	6	50	2	3			
		cv. Hall	20000	29	4	49	1	3			
		cv. Hass	20000	52	9	78	2	6			
Avocado	*Persea americana* Mill	var. Nelan	12800	26	6	44	7	4		(19) as cited by (14)	2
Soursop	*Annona muricata* L.	Not reported	6371	19	4	16	6	0.98	Yield expresed in fresh weight basis, with a density of 277 plants/ha.	(9)	1
Passion flower	*Passiflora edulis* Sims	Not reported	20000	55	6	78	5	4	Experiment performed on basalt and ferrosol soils. The values are the average of	(48)	2

									two study sities.		
Pineaplee	*Ananas comosus* (L.) Merrill	var. Amarilla		175	14	451	52	34	Nutrient extraction correspond to foliage.	(67) as cited by (14)	2
				52	10	125	26	13	Nutrient extraction correspond to fruits.		
Pineaplee	*Ananas comosus* (L.) Merrill	Not reported	55000	205	25	328	86	25	Nutrient extraction correspond to fruits.	(87) as cited by (14)	2
Pineaplee	*Ananas comosus* (L.) Merrill	Not reported	50000	185	24	292		66	Nutrient extraction correspond to fruits.	(51) as cited by (14)	2
Agronomic											
Arabian coffee	*Coffea arabica* L.	Not reported		141	21	157	47	20	The values of nutrient exported was estimed in plantation of 3 years, with density 1,345 trees/ha.	(28)	2
Arabian coffee	*Coffea arabica* L.	Not reported	10000	61	5	56	11	2		(22)	1
Arabian coffee	*Coffea arabica* L.	var. Caturra	11138	187	16	247	27	18	Nutrient exported values were estimed in 2 year old orchard, at fruit maturity.	(79)	1
Arabian coffee	*Coffea arabica* L.	var. Costa Rica-95	14100	64	5	98	12	6	Nutrient extraction correspond to fruits.	(27) as cited by (14)	2
				178	17	158	130	29	Nutrient extraction was evaluated in the vegetative part (leaf, stem and root).		
Arabian coffee	*Coffea arabica* L.	var. Catuai	11800	57	5	83	10	4	Nutrient extraction was correspond to fruits.		
				117	10	133	77	15	Nutrient extraction was evaluated in the vegetative part (leaf, stem and root).		
Arabian coffee	*Coffea arabica* L.	cv. Mundo novo IAC 388-17		336	20	353	243	65	Values corresponded to density of 4000 plants/ha, in reproductive first stage of the cycle of growth.	(64)	2
		cv. Catuai amarelo IAC 62va. Caturra		406	26	374	291	84	The values corresponded to density of 5,000 plants/ha, in first annual production cycle (approx. 2 year old trees).		

Rice	*Oryza sativa* L.	Not reported	5000	110	15	129	21	14	Yield and nutrient extraction correspond to grain only.	(74)	
Rice	*Oryza sativa* L.	var. CR-1821	9300	124	30	23	6	9	Yield and nutrient extraction correspond to grain only.	(31)	1
			11000	75	11	242	63	27	Yield and nutrient extraction correspond to straw only.		
Rice	*Oryza sativa* L.	var. BR3	4400	168	27	163			Experiment performed in Bangladesh in Chhiata clay loam soil. Values are the average of three years during dry and wet season.	(86)	1
Rice	*Oryza sativa* L.	Not reported	4487	173	37	254	26	20	Experiment performed in Brazil in Inceptisols soil. Yield correspond to the grain. Nutrient extraction was evaluated in the straw and grains at physiological madurity (approx. 120 days after sowing).	(36)	1
Rice	*Oryza sativa* L.	var. IR36	9800	143	26	26	1	10	Experiment performed in Philippines. The crop was fertilizer with 174-17-33 kg/ha of N, P and K. Nutrient extraction corresponds to the grain.	(33)	2
			8300	75	5	232	27	13	Experiment performed in Philippines. The crop was fertilizer with 174-17-33 kg/ha of N, P and K. Yield and nutrient extraction corresponds to the straw.		
Rice	*Oryza sativa* L.	var. hybrid Gangyou 527	6996	117	24	156			Experiment performed on sandy loam soil, with traditional flooding. Grain and straw yields were determined at maturity (196 days after transplanting).	(60)	1
			6250	99	22	131			Experiment performed on sandy loam soil, with plastic film mulching. Grain and straw yields were determined at maturity (196 days after transplanting).		
Rice	*Oryza sativa* L.	Not reported	9000	175					Experiment performed in International Rice Research Institute (IRRI) in soil Andaqueptic Haplaquoll	(91)	2
			9500	209					Experiment performed in Philippine Rice Research Institute (PRRI) in Vertic Tropaquept soil.		
Rice	*Oryza sativa* L.	var. IR 27316-96-3-2-2	6700	89					Experiment performed in Philippines, during dry season.	(72)	1

Rice	*Oryza sativa* L.	Not reported	7800	148					Experiment performed in Puerto Rico in Coloso clay loam, fertilized with ammonium sulphate at rates of 50, 100 and 150 kg/ha and irrigated by flooding. The nutrient extraction in whole plant, 16 weeks after of planting. Yield and nutrient extraction corresponds to aplication of 150 kg/ha of N.	(90)	2
Rice	*Oryza sativa* L.	Not reported	6000	88	16	16	1	6		(49)	2
Rice	*Oryza sativa* L.	var. cimarron	12518	151	31	195			Experiment performed in Venezuela. Values of extraction and yield corresponden to 109 days after planting.	(71)	2
Sugarcane	*Saccharum officinarum* L.	Not reported		105	26	208	69	52	Mean value from 3 varieties, includes total aboveground uptake.	(23)	3
Sugarcane	*Saccharum officinarum* L.	Not reported	103000	78	23	343	35	26	Experiment performed in Florida in Histosol, with a density of 160,000 plants/ha. Nutrient extraction in whole plant.	(29)	2
Sugarcane	*Saccharum officinarum* L.	Not reported	127213	87	25	144			Nutrient extraction in whole plant	(35)	
Sugarcane	*Saccharum officinarum* L.	Not reported	100500	106	15	167	30	38		(95)	2
Sugarcane	*Saccharum officinarum* L.	var. H77 siembra	180000	149	57	141	38	158	Nutrient extraction in whole plant, 23 months after of planting.	(16) as cited by (14)	2
Sugarcane	*Saccharum officinarum* L.	var. H77 primera	180000	180	99	177	46	388	Nutrient extraction in whole plant, 20 months after of planting.		
Sugarcane	*Saccharum officinarum* L.	var. H61 segunda	180000	146	56	174	47	144	Nutrient extraction in whole plant, 25 months after of planting.		

1 Confidence associated with the data source. 1 = Highly valid; 2 = Valid; 3 = Poorly valid, see text for details.

Summary

This database serves as a reference to guide the decision in preparing on-farm comprehensive nutrient management plans and as fertilizer guidance. The total plant nutrient extraction can be computed if the plant components (such as fruit, stems, leaves, roots) are weighed and analyzed together or by the sum of the product of the weight and concentration of each of its individual components. The nutrient content of plants varies due to phenology and plant part. Thus maximum nutrient absorption of each plant part at specific physiological growth stages can be identified thus making possible the use of this database for preparing nutrient budgets for those tropical crops and forages herein. From this information, we can also have a clear idea of species that can be used for filter strips, knowing their absorption potential.

Contact

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References

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